# Ocean Dynamics

Robert Pinkel
Marine Physical Laboratory
Scripps Institution of Oceanography
La Jolla California 92093-0213
Phone: (858) 534-2056 fax: (858) 534-7132 email: rpinkel@ucsd.edu

Award N00014-07-1-0354

## LONG-TERM GOALS

To gain a more complete understanding of ocean dynamical processes, particularly at fine-scale, through comparison of high, mid- and low-latitude observations, near the sea surface, in the main thermocline, and near the sea floor.

## OBJECTIVES

To identify the phenomena involved in the cascade of energy from meso-scales to turbulent scales. In particular, we wish to quantify the relationship between fine-scale background conditions and the occurrence of microscale breaking.

## APPROACH

Progress is achieved through a steady-state cycle of instrument development, field observation and data analysis. The primary instruments employed include Doppler sonar and rapidly-profiling CTD's. Our instruments produce information that is quasi-continuous in space and time, typically spanning two decades in the wavenumber domain. This broad band space-time coverage enables the investigation of multi-scale interactions.

## WORK COMPLETED

Our major accomplishments has been the execution of the IWISE South China Sea Pilot Experiment in June 2010. Our objective was to document the generation of large non-linear internal waves in Luzon Strait, scouting spots for detailed study in the coming 2011 intensive field effort. Observations were obtained using the RV Revelle's Hydrographic Doppler Sonar System and a "Lowered ADCP-CTD". Work was conducted in conjunction with Prof Jody Klymak of U. Victoria, Canada and Dr. Oliver Sun, SIO. Our June scouting experiment was coordinated with a subsequent cruise by Matthew Alford, Jen Mackinnon, and Harper Simmons in August-September.

# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **2010** | | **00-00-2010 to 00-00-2010** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **Ocean Dynamics** | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br>**University of California, San Diego,Scripps Institution of Oceanography,Marine Physical Laboratory,La Jolla,CA,92093-0213** | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |

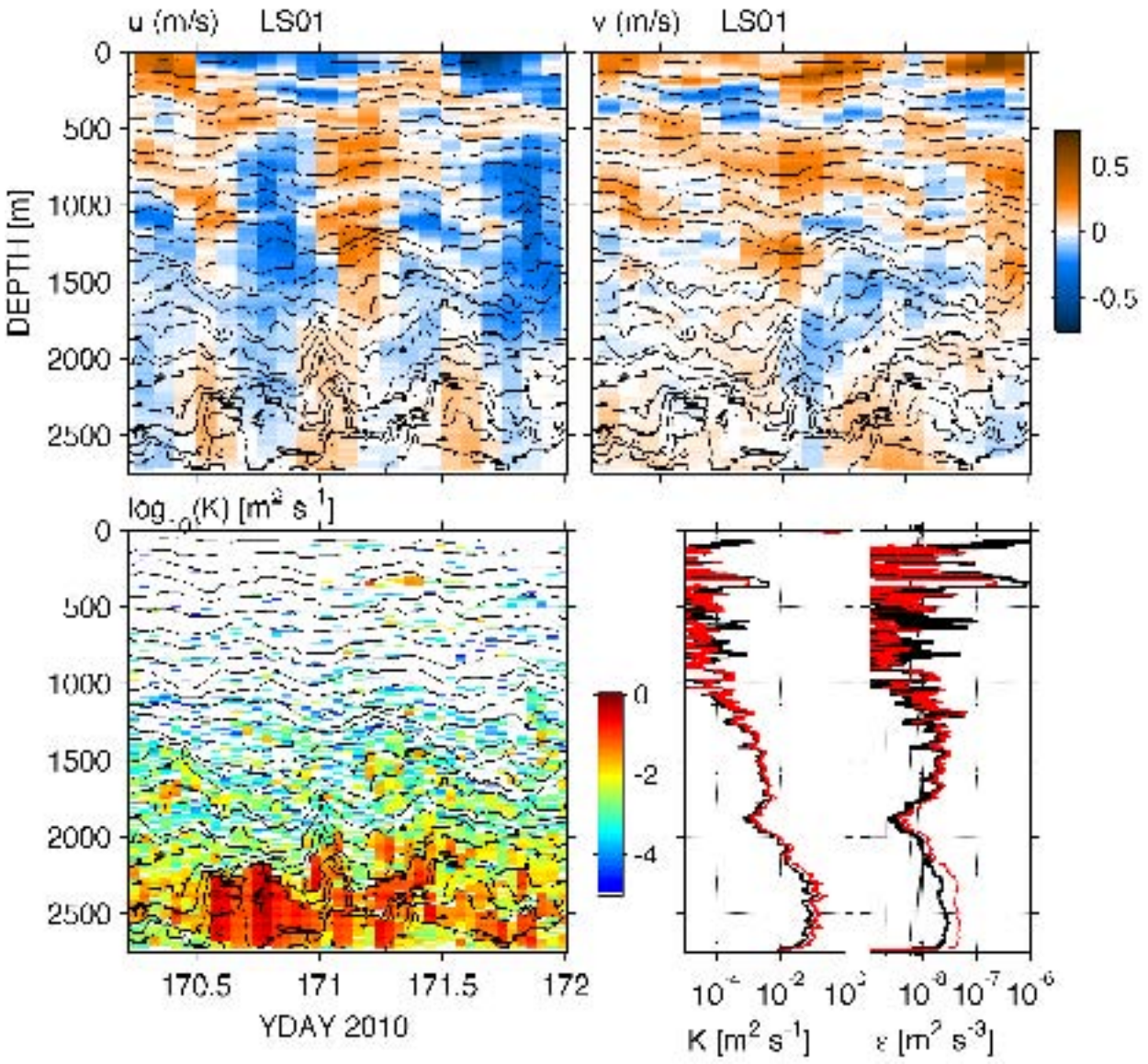
12. DISTRIBUTION/AVAILABILITY STATEMENT
**Approved for public release; distribution unlimited**

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | |
| **unclassified** | **unclassified** | **unclassified** | **Same as Report (SAR)** | **3** | |




**RESULTS**

Profiling with the lowered-ADCP was painfully slow, relative to our "Fast-CTD" instrument which will be used next year in the main experiment. Never the less, regions of massive ocean mixing were found associated with both the diurnal and semi-diurnal tides. The figure above shows elevated mixing levels extending 500-1000 m above the deep (2500 m) sea floor just west of the Strait. Eddy diffusivities approach 1 $m^2/s$, ten thousand times Munk's (1966) canonical deep-sea average value. The complex geography of the Strait and the energetic forcing of the barotropic tides lead to a scenario that differs greatly from the Hawaii Ocean Mixing Experiment, the benchmark study of a super-critical tidal conversion site.

## IMPACT/APPLICATIONS

The IWISE 2010 pilot is suggests that a broad range of phenomena are possible at supercritical tidal conversion sites. Insights from the 2010 and 2011 IWISE experiments will be invaluable in improving the predictability of tidal mixing phenomena, globally.

## TRANSITIONS

In parallel with IWISE, our group has been developing the Wirewalker, a vertically profiling instrument package powered by ocean waves. A number of these devices are planned for use in the coming ONR Air-Sea DRI. The technology has been transitioned.

The first commercial Wirewalker vehicles are now being produced and sold by Brooke Ocean Technology, US.

## RELATED PROJECTS

To investigate deep nonlinear phenomena, it is necessary to provide even greater depth-time coverage than the Wirewalker or conventional shipboard systems can provide. In IWISE 2011, we plan the improvement of our Fast CTD to work at depths between 500-1500 m in regions of strong current such as Luzon Strait. With a 3-5 m/s profiling speed, a range of non-linear motions will be detectable for the first time,

## REFERENCES

Munk, W.H., 1966: Abyssal Recipes.

## PUBLICATIONS

Klymak, J. M. , R. Pinkel, C.T. Liu, A.K. Liu, and L. David. Prototypical solitons in the South China Sea. Geophys. Res. Letters, 33 L11607, 2006.

Klymak, J. M., M. Alford, R. Pinkel, R.C. Lien and Y.J. Yang. The breaking and scattering of the internal tide on a continental slope. J. Phys. Oceanogr., Accepted.

Pinkel, R., M. A. Goldin, J. A. Smith, O. Sun, A. Aja, M. N. Bui, T. Hughen. The Wirewalker, a vertically profiling instrument package powered by ocean waves. J Atmospheric and Oceanic Tech., in press.